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ABSTRACT

Based on the assumption that each student learns in a unique way, this paper outlines the factors to be considered before selecting the methods of instruction for particular mathematics courses and their students. The advantages and disadvantages of the lecture/textbook and question/answer method, individualized instruction, self-pacing, discussion/demonstration, field experiences, and tutorials are described. Characteristics of courses and students, and suggestions regarding these methods of instruction are outlined for the following elements of a mathematics curriculum: (1) pre-college courses--vocational-technical, arithmetic, elementary algebra, intermediate algebra; (2) first year courses--college algebra, trigonometry, modern mathematics I and II, liberal arts mathematics, statistics, mathematics for business, and economics I and II; and (3) second year courses--pre-calculus, calculus I, II, and III, and differential equations. Other considerations in program development include instructor role, media, counseling, placement testing, student follow-up, tutoring, funding, and attendance. A summary of cognitive mapping, a list of textbooks, and a bibliography are included. (MB)

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SOME CONSIDERATIONS IN COMBINING TRADITIONAL AND NON-TRADITIONAL METHODS OF INSTRUCTION IN A MATHEMATICS PROGRAM

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Introduction

The underlying assumption of this presentation is that each individual student learns in his particular unique way. It is important, therefore, that the instructor and the educational institution provide, if possible, various means of instruction to accommodate these personal learning styles. The instruction can range from the traditional lecture-textbook method to highly sophisticated, media supported, unusually innovative methods. Many factors must be considered before selecting the methods of instruction for a particular course and its students. For mathematics programs, the primary factors to be considered are:

I. Methods of Instruction

II. Structure of the Mathematics Program

III. Characteristics of the Courses

IV. Characteristics of the Students in Those Courses

Once I, II, III, and IV are carefully examined, the instructor and/or the mathematics staff should determine how a particular course can and should be taught. This presentation will offer suggestions on how these determinations are made and why they are made.

I. Methods of Instruction

A. Lecture/Textbook, Question/Answer

B. Individualized Instruction

C. Self-Pacing

D. Discussion / Demonstration

E. Field Experiences

F. Tutorial

A. Lecture-Textbook Method of Instruction

The lecture method of instruction consists of having an instructor stand in front of a group of students, transmit facts and information, answer questions, and assign homework problems, usually from the textbook. Every class is just about the same except on those days when an exam is given or explained. This method is very traditional and is quite effective for some courses.

Advantages of the Lecture Method

1. Most students are familiar with this method (whether or not they learn by it).
2. Very efficient for the instructor in the conveyance of ideas, facts and concepts.
3. Assists students in understanding the text better and permits students to have immediate feedback on any questions.
4. Requires no special equipment (usually only chalk and a board).
5. Large numbers of students can be taught this way.
6. Instructor can add a very human touch to the activity.

Disadvantages of the Lecture Method

1. The lecture may reach only 40%-50% of the students. Those who, in the past, were not successful with it usually won't be now.

2. Students tend to learn more math with a combination of explanation (audio) and illustrations (visual). If visual assistance and illustrations are lacking, the lecture is serving only a small population of the class.

3. Students must be good listeners and note-takers.

4. Usually there is not time to repeat lectures on difficult material.

5. Personality of the instructor can make a lecture deadly.

6. Students cannot participate as much as they could and should because of time restraints.

7. Difficult to ascertain whether students are understanding anything.

8. Difficult for the student to take notes and listen at the same time.

B. Individualized Method of Instruction

Individualized instruction is a design for instruction which takes into account the individual learning styles of the students. This method of instruction must consider the background of students, how the students have learned successfully in their past, selection of learning materials and resources to satisfactorily accommodate the different learning styles, and selection of the preferred learning environment.

Advantages of the Individualized Method

1. If one assumes that every person learns differently then every attempt must be made to provide a means for each student to learn according to his style of learning.

2. Students feel as if they have a choice as to how they will learn the material. They are not in a "take it or leave it" situation.

3. Students should be more highly motivated as they have more responsibility for their own learning. In fact, the student sometimes can design an effective means of learning the course themselves.

4. Time usage of the student is improved.

5. Time usage of the instructor is improved.

Disadvantages of Individual Instruction

1. Instructor(s) may not subscribe to the fact that every person learns differently.

2. This method of instruction takes a lot of time to conceive, design, implement, use, refine and evaluate.

3. The instructor turns into more of a manager of a learning system rather than acting as a primary resource for instruction (lecturer).

4. Production of individualized learning systems can be very costly, involve many people, and require special equipment and facilities.

5. Some students may react negatively toward this method because of their unfamiliarity with it.

C. Self-Paced Method of Instruction

Self-pacing is a method of instruction in which a student can start, progress, and finish a course at his or her own rate. This method of instruction should not be confused with individualized instruction. These two methods can be used separately or together.

Advantages of Self-Pacing

1. The highly motivated student can finish the course as quickly as is desired.

2. The student is not held back by a method of instruction which is not consistent with his style (lecture), leading to frustration and boredom.

3. In finishing a course early in a semester, the student has more time for his other courses at the end of that semester.

Disadvantages of Self-Pacing

1. This option must be thoroughly explained to students opting for it.

2. Monitoring of student progress may be a problem. There must be a mutual agreement between student and instructor that the student is doing this.

3. Attendance would obviously be lacking in class by the student. The student shoudl periodically report to the instructor about his progress (this could be done by testing).

4. Materials may be difficult to find or produce to allow students to select this method of instruction.

D. Discussion Method of Instruction

The discussion method of instruction involves the bringing together of students to interchange ideas, thoughts, techniques, and personal strategies in order to achieve the common goals or outcomes of the class in which they are enrolled.

Advantages of the Discussion Method

1. The students and instructor can interact more informally and be more involved with each other in a "low-keyed" manner.

2. Communication skills are increased.

3. Student interest is increased and students are sometimes more interested in helping others in the class learn the material (taking responsibility for each other's success).

4. Provides immediate feedback for the instructor.

Disadvantages of the Discussion Method

1. It takes up a lot of time.

2. Discussion could get out of control and off the track.

3. Some students feel uncomfortable with this method and would not contribute.

4. Instructor preparation must be adequate both in being able to lead a meaningful discussion and in the content of the discussion.

E. Field Experiences

The field experience method of instruction permits the student to participate in out-of-classroom activities selected to provide practical experiences. This method helps to answer the question "What is the good or usefulness of what I am learning?"

Advantages of the Field Experience

1. Takes the student out of the academic setting into the world of real life.

2. Lends itself to individual learning differences and styles.

3. Applies the classroom theory and concepts to practical everyday situations.

4. May influence the student about career objectives.

Disadvantages of the Field Experience

1. Requires careful planning on the part of the instructor, student, and field contact to make the experience worthwhile.

2. The student must have sufficient initiative, motivation, and inter-personal characteristics to go and complete the outside assignments. This may cause some problems with some students and may cause embarrassment for the instructor or the outside contact.

F. Tutorial Method of Instruction

The tutorial method of instruction is usually a one-to-one relationship between student and instructor. This is done if a student cannot register for a course but needs it to graduate, if the student has a special handicap, or if another very special problem arises.

Advantages of the Tutorial Method

1. Students get very special attention.
2. Instructor has complete control of the situation.
3. Learning strategies, materials, and approaches can virtually be changed from meeting to meeting.
4. Scheduling is quite flexible.

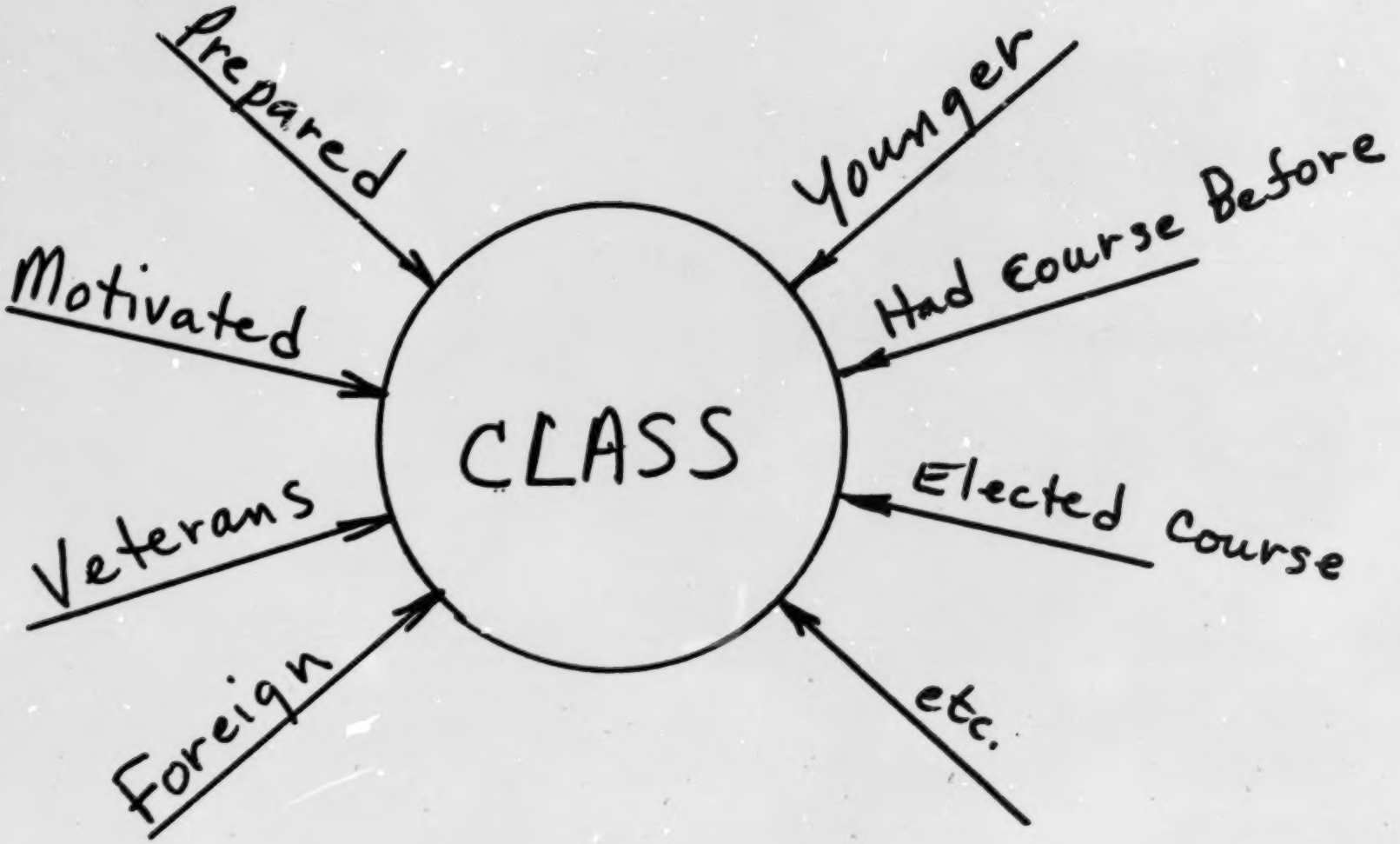
Disadvantages of the Tutorial Method

1. Time and energy demands could be overwhelming for both instructor and student.
2. Pairing a student with an instructor must be done with care to avoid personality differences.

II. Structure of a Mathematics Program at a Community College

(This represents the program at Austin Community College)

Pre-College Courses	First Year Courses	Second Year Courses
Vocational-Technical Arithmetic	College Algebra	Pre-Calculus
Elementary Algebra	Trigonometry	Calculus I
Intermediate Algebra	Modern Mathematics I and II	Calculus II
	Liberal Arts Mathematics	Calculus III
	Mathematics for Business and Economics I and II	Differential Equations


Prepared
Younger
Had Course Before
Motivated
CLASS
Elected Course
Veterans
Foreign
etc.

III and IV. Characteristics of Courses and Their Students

A. Vocational Technical Courses (no pre-requisites)

1. Characteristics of Courses

a. Arithmetic with Applications
b. Basic Algebra with Applications
c. Basic Right Triangle Trigonometry with Applications
d. Basic Geometry with Applications
e. Metric System
f. Not transferrable to senior institutions
g.

2. Characteristics of the Students

a. Vocationally-Technically-Occupationally oriented.
b. Manually oriented.
c. Prefers to see math applied rather than just learn math theory (formulae, theory, etc.)
d. Reading level is relatively low (5th-9th grade level).
e. Many students work at full and part-time jobs.
f.

3. Suggested Methods of Instruction

a. Lecture - Many students are familiar with lectures and can learn by it.
b. Individualize - Try to select or develop materials keyed to a student's vocational-technical program. Try to provide many visual aids (video tapes, films, slides, etc.) as these types tend to be quite visually oriented.
c. Self-Pacing - Many of the topics in these courses have been studied before, so let the student finish those subjects as quickly as possible with properly selected materials.
d. Discussion/Demonstration - Think of all the possibilities here. Meter sticks, gears, carburetors, testing machines, oscilloscopes, etc. One of the few courses with all these various ways of applying the mathematics.

e. One of the courses which offers the greatest challenge for design and implementation.
f. Field Experiences - Not too important, but can be used in special situations.
g. Tutorial - To be used for special students having unique learning difficulties.

B. Arithmetic (no pre-requisites)

1. Characteristics of the Course

a. Covers the foru basic operations of addition, subtraction, multiplication, and division of signed numbers, fractions, and decimals.
b. Covers the three cases involving percent problems.
c. Introduction to algebra.
d. Graphs, charts, tables.
e. Metric system
f. Not transferrable to senior institutions.
g.

2. Characteristics of Students

a. All types (age, race, socio-economic, ability, etc.)
b. All students have studied basic material before:
   (1) for review;
   (2) never really learned it the first time;
   (3) to regain their confidence and overcome their fear of math;
   (4) to get easy 3 credits at the community college;
   (5) no other course to take at registration;
   (6) pre-requisite for next course (Elementary Algebra);
   (7) requisite for a particular program.
c. Some students have been out of school for quite awhile.
d.

3. Other Characteristics

a. Reading level is relatively low (5th-9th grade level).
b. Many students work at full and part-time jobs.
c.

4. Suggested Methods of Instruction

   a. Lecture - To some students this is just what they want. Some students do not read well and will depend on the spoken word for their instruction.
   b. Textbook must be chosen to accommodate two characteristics (i.e., low reading level and the fact that most students have studied the content before).
   c. Individualized Instruction - Usually not that necessary here because most students are reviewing the basic content.
   d. Self-Pacing - Extremely important for this course. Select a text so that students can possibly study on their own and provide a test system so that they can finish the course as quickly as they are able.
   e. Discussion/Demonstration - Not that important for this course, but don't exclude the possibility completely.
   f. Field Experiences - Not necessary.
   g. Tutorial - Needed by students having unique learning difficulties.

C. Elementary Algebra (pre-requisite of Arithmetic)

1. Characteristics of the Course

a. Topics normally covered in first year high school algebra.
b. Not transferrable to senior institutions.
c.

2. Characteristics of the Students

a. Some students have had the course before:
(1) review;
(2) never really learned it the first time;
(3) to regain confidence and overcome fear of elementary algebra;
(4) for 3 hours of community college credit;
(5) required for particular program;
(6) to meet pre-requisite for next math course (Intermediate Algebra, Statistics, Modern Math I, Liberal Arts Math, Math for BUA/ Eco I).
(7)

b. Some students have not had the course before:
(1) learning material for the first time;
(2) for 3 hours of community college credit;
(3) required for particular program;
(4) to meet pre-requisite for next math course (Intermediate Algebra, Statistics, Modern Math I, Liberal Arts Math, Math for BUA/ Eco I).
(5)

3. Other Characteristics

a. Reading level is relatively low (5th-10th grade).
b. Many students work at full or part-time jobs.
c.

4. Suggested Methods of Instruction

   a. Lecture/Textbook - Both are needed and should be used.
   b. Individualized Instruction - Less important and possible than in two previously discussed courses. Since this course attempts to teach one year of high school algebra in one semester, the primary means of instruction should be lecture/textbook. Keep your eyes open, though, for materials treating certain topics in different ways.
   c. Self-Pacing - Try to select a text which can provide self-pacing for those students reviewing the material. There are plenty of texts available which will do this. Be careful of reading level of the selected text.
   d. Discussion/Demonstration - Time restraints almost prohibit this method of instruction.
   e. Field Experiences - Not necessary.
   f. Tutorial - Again used for special students having unique learning problems.

D. Intermediate Algebra (pre-requisite of Elementary Algebra)

1. Characteristics of the Course

a. Topics usually covered in second year high school algebra.
b. Not transferrable to senior institutions.
c.

2. Characteristics of the Students

a. Few students have had the course before:
(1) review;
(2) never really learned it the first time;
(3) for 3 hours community college credit;
(4) required for particular program (photography)
(5) to meet pre-requisite for next math course (college algebra, pre-calculus, etc.)
(6)

b. Most students have not had the course before:
(1) learning material for the first time;
(2) 3 hours community college credit;
(3) required for particular program;
(4) to meet pre-requisite for next math course (college algebra, pre-calculus, etc.)
(5)

3. Other Characteristics

a. Reading level is relatively low (6th-10th grade).
b. Many students work at full and part-time jobs.
c.

4. Suggested Methods of Instruction

a. Lecture - The mainstay for those students who prefer it. One must not forget that this course attempts to cover the basic topics of the second year of high school algebra.
b. Text - should be chosen to reflect the reading level of the students, but not necessarily designed for self-pacing as most students have not had this course before.
c. Self-Pacing - Less important than previously discussed courses. Hardly any new students to the subject would be successful with self-pacing if the option was provided.
d. Discussion/Demonstration - Time restrictions and quantity of material prevent this option.
e. Field Experiences - Not necessary.
f. Tutorial - For students with special problems.

E. College Algebra (pre-requisite of Intermediate Algebra)

1. Course Characteristics

a. Topics usually covered in standard college algebra course.
b. Sometimes transferrable to senior institutions.
c. Course content must prepare students for calculus.
d. Has more theoretical topics than previous courses.
e.

2. Characteristics of the Students

a. Few students have had the course before:
(1) review;
(2) never really learned it the first time;
(3) required for a particular program (Electronics);
(4) 3 hours credit at community college and may be transferrable credit to senior institution
(5)

b. Most students have not had the course before:
(1) learning material for the first time;
(2) required for a particular program;
(3) 3 hours credit at the community college and may be transferrable credit to senior institution.
(4)

3. Other Characteristics

a. Reading level is moderately high (8th-12th grade level).
b. Many students work at full or part-time jobs.
c.

NOTE: Since this course may be the first course that will probably transfer to a senior institution, students will actually demand (under warning, at times) to take this course, whether or not they are ready for it.

4. Suggested Methods of Instruction

   a. Lecture/Textbook - Necessary for the course for some students.
   b. Individualized Instruction - Try to use many visual aids such as video tapes, slides, transparencies, etc. The attrition rate for this course could be quite high because it is one of the first "transfer" courses and students will take it for that reason whether or not they are ready for it. This is one of the most difficult courses to instruct. Use as many methods of instruction suited to learning styles as are available.
   c. Self-Pacing - Desirable but difficult because of the lack of good published materials designed for it.
   d. Discussion/Demonstration - At this point in the mathematics courses continuum, more time should be allowed for discussion of particular theories and problems among the instructor and the students and among the students themselves. This course could be the place where peer assistance and influence may be as important as the lecture/text and instructor as a primary means of instruction.
   e. Field Experiences - Not necessary.
   f. Tutorial - As needed by students with special problems.

F. Trigonometry (pre-requisite of College Algebra)

1. Course Characteristics

a. Topics usually covered in a standard trigonometry course.
b. Sometimes transferrable to senior institutions.
c. Course must provide essential trigonometry topics used in the calculus.
d. This course is usually a little easier for students to learn than college algebra.
e. Many more practical applications than the college algebra.
f. The hand-held calculator can be used extensively in trigonometry.
g. The course seems to be more interesting to students than college algebra.
h.

2. Student Characteristics.

a. Many students have had trigonometry in high school, vocational-technical school or in the service:
(1) review;
(2) never really learned it the first time;
(3) required for a particular program (land-surveying);
(4) 3 hours credit at the community college and may be transferrable to senior institutions;
(5)

b. Many students have not had trigonometry.
(1) learning material for the first time;
(2) required for a particular program;
(3) 3 hours credit at the community college and may be transferrable to senior institutions;
(4)

3. Other Characteristics

a. Reading level is moderately high (8th-12th grade level).
b. Many students work at full or part-time jobs.
c.

NOTE: Since this course may be another course that will transfer to a senior institution, the student may demand to take it whether or not he is ready for it.

4. Suggested Methods of Instruction

a. Lecture/Textbook - Since this course tends to be a little easier and more interesting than College Algebra (pre-requisite), the lecture/textbook approach can be de-emphasized a little, but should be provided.
b. Individualized Instruction - Many students have had trigonometry in high school and text and materials can be chosen to accommodate these students. There are many different texts, visuals, and audio tapes on this subject commerically available.
c. Self-Pacing - By all means allow interested students having had the material before to learn as quickly as they can on their own. This course can be designed to do this.
d. Discussion/Demonstration - This course lends itself to this method beautifully. Think of all the ways the theories and formulae of trigonometry can be applied to the real world. There are countless possibilities and the instructor should seek and take advantage of them, making the course very relevant, exciting, and fun. Bring in science teachers from the school for demonstrations.
e. Field Experiences - This course, again, lends itself beautifully to this method of instruction (height of a flagpole, width of a river, elevation of the sun, etc.).
f. Tutorial - Again, there will be those students who will need special help.

G. Modern Mathematics I and II (pre-requisite Elementary Algebra).

1. Course Characteristics

a. Topics covered are those normally found in courses designed to meet the minimum math requirements for a degree in elementary education.
b. This sequence of two courses is a terminal course.
c. Students are mostly in elementary education.
d. Course is transferrable to a senior institution.
e.

2. Student Characteristics

a. Most students have not taken the course(s) before.
b. Many students don't like mathematics and take the course because they must meet their degree requirements.
c. Most students are female.
d.

3. Other Characteristics

a. Reading level is moderately high (8th-12th grade).
b. Many students work at full or part-time jobs.
c.

4. Suggested Methods of Instruction

a. Lecture/Textbook - This is the method primarily used and is effective. Most students are future elementary school teachers whose mathematics training will end with this course. These students feel very comfortable with this method.
b. Individualized Instruction - Some attempt should be made by the instructor to share with these potential teachers the fact that

students (children) learn differently and should continue throughout the course(s) to give examples of the different ways learning can take place. It may give the students some ideas about what they can use in their future profession.

c. Self-Pacing - Not necessary.
d. Discussion/Demonstration - If an occasion arises during the course(s), it should be taken advantage of.
e. Field Experiences - Not necessary.
f. Tutorial - For those needing it.

H. Liberal Arts Mathematics Course (pre-requisite of Elementary Algebra).

1. Course Characteristics
   a. Usually a transferrable course to a senior institution as an elective.
   b. This course is a terminal course.
   c. Instructor probably has greater freedom in structuring this course than in any other course in the mathematics curriculum.
   d. This course probably is the most fun to instruct as the possibilities of form and content can be greatly varied.
   e. Perhaps the only course where the socio-economic, cultural, historical, philosophical, and applications to the sciences can be studied to any great extent.
   f.

2. Student Characteristics
   a. Students are interested in mathematics and may or may not be a declared major in any program.
   b. Students need hours of transferrable credit to a senior institution as an elective.
   c. Most students have not taken such a course before.
   d.

3. Other Characteristics
   a. Reading level is relatively high (8th-12th grade level).
   b. Many students work at outside jobs.
   c.

4. Suggested Methods of Instruction
   a. Lecture/Textbook - Recommended for this course. There are many beautifully written texts which treat many topics in arts, music,

J. Mathematics for Business and Economics (pre-requisite of Intermediate Algebra)

1. Course Characteristics
   a. Topics normally covered in such a course.
   b. Designed exclusively for business and economics majors.
   c. Transferrable to most senior institutions.
   d. Usually not a terminal mathematics course for these students.
   e. Carries more theoretical topics than previous courses with more sophisticated applications.
   f.

2. Student Characteristics
   a. Very homogeneous group, being comprised almost exclusively of business and economics majors and/or persons working in business and industry.
   b. Some have had the course before and need a review.
   c. Some have never taken the course before.
   d. Many students are older (especially those taking the course at night school). These older, business-experienced students are a valuable source of input to the classes which they attend.
   e.

3. Other Characteristics
   a. Reading level is relatively high (9th-14th grade level).
   b. Most students are currently working at full or part-time jobs directly related to business and industry.

before class helps them to preview your lecture before you give it. It is difficult to listen to a lecture and take adequate notes at the same time.

c. Self-Pacing - Try to pick a text with an accompanying workbook, so that highly motivated students can progress on their own in some parts of this course. There do exist published materials which allow for this option.

d. Discussion/Demonstration - To be used as the situation arises.

e. Field Experiences - Usually not necessary, although some students may want to do something extra.

f. Tutorial - For those who need it.

computer, logic, history, and philosophy. Here is a great opportunity to select a book according to the teacher's special interests, background and skills.

b. Individualized Instruction - Do it. Because of the variety of topics available in this course one could, virtually, allow the student to design his own course to a great degree. Different teachers could be used throughout the course lending different approaches and interests.

c. Self-Pacing - Depends on how the course is designed. If reports on mathematicians, book reviews, and other activities are planned, then the student can do these at any time.

d. Discussion/Demonstration - This can be used extensively. Gambling demonstration for probability. Discussion of the history and philosophy of mathematics, pointing out key periods and their developments are fun. The instructor has a great deal of freedom with this method of instruction.

e. Field Experiences - Students could be sent out to interview people in business and industry about how they use mathematics.

f. Tutorial - For those who need it.

I. Statistics (pre-requisite of Elementary Algebra)

1. Course Characteristics
   a. Topics typically covered in an elementary statistics course.
   b. Usually transferrable to most senior institutions as a statistics course or an elective.
   c. Great diversity of students:
      (1) nurses;
      (2) education majors;
      (3) science majors;
      (4) business majors;
      (5) undeclared majors.
   d. Usually a terminal course in statistical sequence for these students.
   e.

2. Student Characteristics
   a. Some have had statistics before:
      (1) review;
      (2) never really learned it the first time;
      (3) required for credit at the community college and as a required course or elective at a senior institution.
      (4)
   b. Some have not had statistics before and must learn the material for the first time.

3. Other Characteristics
   a. Reading level is relatively high (8th-12th grade level).
   b. Many students work at outside jobs.
   c.

4. Suggested Methods of Instruction
   a. Lecture/Textbook - Yes.
   b. Individualized Instruction - Like most other courses every attempt should be made to provide the student with other means of learning, to include visuals, video tapes, illustrations, etc. Having lecture notes and diagrams prepared and given to students

4. Suggested Methods of Instruction
   a. Lecture/Textbook - Yes, teach the course in this traditional manner. If the students are prepared (meet the required pre-requisite) most will do well with this method. The majority of the students will be business and economics majors and will apply themselves to the material in a responsible manner. In late afternoon and evening sections, the age of the student increases dramatically and many have extensive experience in the real world. Make sure the instructor is well qualified and experienced to meet this unique group of people.
   b. Individualized Instruction - Not necessary.
   c. Self-Pacing - Not necessary but some students may like to have the option if provided. Most like to go at the regular rate, because of other time demands. Usually these older students are in no real hurry.
   d. Discussion/Demonstration - Use this method as often as possible in class. Because of the nature and background of the student, this method can be very valuable, especially for the younger students exchanging ideas and experiences with the older students.
   e. Field Experiences - Use if time permits. Sometimes, though, because of time demands these students will be reluctant to do this. Maybe one such well thought-out experience will suffice, especially for the younger student.
   f. Tutorial - For those who need it.

K. Pre-Calculus (pre-requisite of Intermediate Algebra with a high grade B or better).

1. Course Characteristics
   a. Covers topics normally covered in a pre-calculus (functions) course. These topics cover both those of college algebra and trigonometry.
   b. Course usually carries more credit hours than a "normal" community college math course, is greatly accelerated, and is for the better student.
   c. Credits transferrable.
   d. Prepares the student for Calculus I.
   e. More theoretical than previous courses.
   f.

2. Student Characteristics
   a. Students have usually not taken the course before.
   b. Students usually are and should be of superior math ability and performance.
   c. Students will most probably enroll in Calculus I.
   d. Students are mathematics, engineering, physics, and other majors which will require this course, calculus, and higher mathematics and science courses.
   e. Some foreign students.
   f.

3. Other Characteristics
   a. Reading level is relatively high (9th-14th grade level).
   b. Some students have outside employment.
   c.

4. Suggested Methods of Instruction
   a. Lecture/Textbook - From this level and above this should be the primary means of instruction. It is important that the student be involved with the instructor to exchange questions

and answers. This verbal exchange between instructor and student along with the "verbal exchange" between text and student should (must) be supplemented by an abundance of visual material of every conceivable nature. This is necessary because students prefer visually assisted explanations in class to assist in their learning.

It should be remembered that at this point the student is near leaving the community college on his way to the senior institution which will probably use the lecture/textbook method. On the other hand the use of visual aids and materials will assist the student while he is still at the community college.

b. Individualized Instruction - Lecture/textbook and visual aids will be sufficient for the great majority of students, so the effort to individualize may not be worth the effort it would take to provide it.
c. Self-Pacing - Not recommended because of the abundant content and nature of the material. Don't try it.
d. Discussion/Demonstration - Use this method within the lecture/textbook method. At this level it is important for there to be a healthy exchange between the instructor and students and between the students themselves. Don't waste a lot of time doing it, though.
e. Field Experience - Does not apply to this course.
f. Tutorial - For those who need it.

L. Calculus I (pre-requisite of College Algebra and/or Pre-Calculus).

1. Course Characteristics
   a. Topics normally covered in a beginning calculus course.
   b. Course usually carries 4 or 5 credit hours.
   c. Transferrable to virtually all senior institutions.
   d. Prepares the student for Calculus II.
   e. This course is a large step forward in the mathematical maturation of the student. This is, sometimes, the course which makes the student decide whether or not to go on in mathematics, engineering, etc.
   f.

2. Student Characteristics
   a. Students have usually not taken the course before.
   b. Students should be and usually are of superior mathematical ability and maturity and can perform accordingly.
   c. Students sometimes have difficulty with the algebra required to do the calculus.
   d. Students will usually go on to Calculus II and higher courses, eventually transferring to senior institutions as math, engineering, science, dental, medical, business, and other majors requiring the calculus.
   e. Many foreign students.
   f.

3. Other Characteristics
   a. Reading level is relatively high (10th-14th grade level).
   b. Some students have outside employment.
   c.

4. Suggested Methods of Instruction.

a. The methods of instruction here are basically the same as for the Pre-Calculus course. One must exercise a great deal of care with the lecture presentations as the first calculus course is a traumatic experience for many students. The instructor should go quite slowly at first and make sure the basic concepts of limit, continuity, and derivatives are well understood. Some instructors can hardly wait to get into difficult and sophisticated (but beautiful) examples and exercises, but the students' understanding and feelings about the basic concepts must come first. Let the students get their feet on the ground the first five or six weeks.

Be very careful in the selection of a text. Select it with the student in mind, not for the instructor or because of where the student may transfer.

Provide as much visual material as possible. One could allow the video taping of the well-prepared lectures so that interested (or absent) students may review them as often as they wish. Many visual examples are important here as helps to the students.

b. Individualized Instruction - To try to do more than is mentioned above is usually not worth the effort because of the time, talents and interests of most instructors and the nature of the material. There are some individuals, though, who are making and have made such attempts, and have been relatively successful. Try to seek them out and inquire about their results.

c. Self-Pacing - It is difficult for a student to do this in the calculus using a standard text, unless the student is reviewing the course and can read the book himself. There is not much good material commercially available which is designed for self-pacing in calculus.

d. Discussion/Demonstration - Very important in this course, so do it as often as you can.

e. Field Experience - Does not apply to this course.

f. Tutorial - The need for this method might be greater for this course because of its nature, so be prepared for a lot of questions from a lot of students. One might consult with the counselling office to provide tutors for those who need help. A math lab or parallel studies operation could also do it.

M. Calculus II (pre-requisite of Calculus I)

1. Course Characteristics
   a. Topics normally covered in a second semester calculus course.
   b. Course usually carries 4 or 5 credit hours.
   c. Transferrable to virtually all senior institutions.
   d. Prepares the student for Calculus III and/or Differential Equations or other sophomore and junior level courses.
   e. Students will usually transfer to a senior institution after this course.

2. Student Characteristics
   The characteristics of the student in Calculus II are about the same as Calculus I.

3. Other Characteristics
   a. Reading level is relatively high (10th-14th grade level).
   b. Some students have outside employment.
   c.

4. Suggested Methods of Instruction

   Similar to those of Calculus I. The students of Calculus II have "weathered the storm" of Calculus I and should know quite well what is happening, what they have to do, when they have to do it, and how they are to do it. These students will usually perform well in this and future mathematics courses. Don't let this fact, though, make the instructor become lax in the presentations or the general effort. The same degree of concern and preparation must be continued and, in fact, might have to be better because these students really know what's going on for the most part.

N. Calculus III (pre-requisite of Calculus II)

1. Course Characteristics
   a. Topics normally covered in a third semester calculus course.
   b. Course usually carries 4 credit hours.
   c. Transferrable to virtually all senior institutions.
   d. Prepares the student for Advanced Calculus, Real Analysis, and/or other higher courses.
   e. Student will transfer to senior institution after this course.

2. Student Characteristics
   Same as Calculus II

3. Other Characteristics.
   Same as Calculus II.

4. Suggested Methods of Instruction
   Same as Calculus II

O. Differential Equations (pre-requisite of Calculus II)

1. Course Characteristics
   a. Topics normally covered in a beginning differential equations course.
   b. Course usually carries 3 or 4 credit hours.
   c. Transferrable to virtually all senior institutions.
   d. Prepares the student for advanced Differential Equations courses.
   e. Students will transfer to a senior institution after this course.
   f.

2. Student Characteristics
   Same as Calculus II.

3. Other Characteristics
   Same as Calculus II

4. Suggested Methods of Instruction
   Same as Calculus II

Other Considerations

1. Instructors on the mathematics instructional staff.

   a. That one instructor be the "primary" instructor to monitor the development of any one course with, of course, the involvement and input of the other instructors. This may be difficult, though, in a multi-campus college operation.

   b. That all instructors in a mathematics program teach courses at all levels of the program for the students' benefit and also the instructional staff.

   c. That the instructors inform the students of the possible alternatives for learning. Many students are unaware of the various possibilities to be considered other than, perhaps, lecture-textbook.

   d. That all instructors eventually provide at least three ways (alternatives) for instruction in each course, except possibly for the calculus and differential equations.

   e. That, initially, an instructor concentrate on the development of only one course at a time, then use the knowledge gained to develop other courses. It is usually best to do a good job in one course than to do a mediocre job in many courses.

   f. That the instructor make it clear that there is a shared responsibility for learning between the student and the instructor. The concerns of a student which should be answered by the management system are these:

      (1) What am I supposed to know?
      (2) What if I already know it?
      (3) If I don't know it, how do I go about learning it?
      (4) What materials will help me learn it?
      (5) Where are these materials?
      (6) How do I know when I know?
      (7) How can I prove that I know it?
      (8) Now that I know it, where do I go?
      (9) Am I working efficiently?
      (10) How am I doing?
      (11) How do I compare with others?

The concerns of a teacher which should be answered by the management system are these:

(1) What should the student know?
(2) What materials do we have to help him learn?
(3) How can we help him decide when he knows?
(4) Where is the student with respect to his work?
(5) How well is he doing?
(6) Where is the class with respect to the course?
(7) Who is in class today?
(8) Where are the learning resources NOW?

g. That some instructors have special talents, abilities and interests which should be recognized and utilized in course development and operation.

h.

2. Media production personnel and facilities.

3. Counselling and Guidance - Have a special counselor to handle the mathematics students. Visiting of classrooms by this person.

4. Reading level determination of the classes and the reading materials used in them.

5. Scheduling

6. Placement testing - Initial placement of students in the correct course according to their current abilities.

7. Follow-up of students leaving a particular course. How are they doing in its sequel?

8. Learning (Cognitive) Style determination by using cognitive style mappings. For more information on this concept, contact:

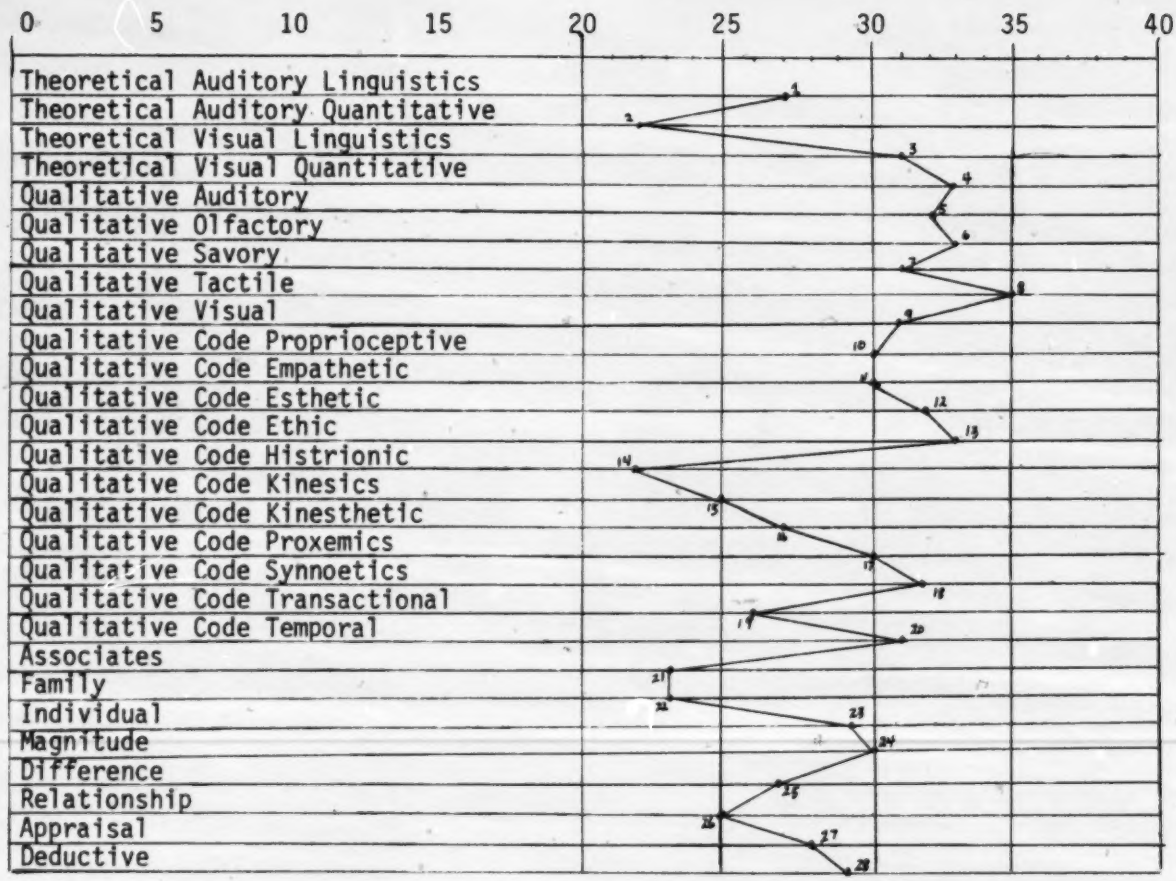
Dean of Instruction
Mountain View College
4849 W. Illinois Avenue
Dallas, Texas 75211

9. Transition Shock (traditional instruction to non-traditional and vice-versa).

10. Parallel Studies Programs.

11. Tutoring Assistance

12. Funding
13. Release Time for Curriculum Development
14. Veterans and their special needs and problems.
15. Re-testing
16. Testing Centers
17. Grading (Different for different courses?)
18. Attendance
19. Behavioral (Learning Objectives)
20. Incomplete Grades
21.



Cognitive Style Mapping Summary

Cumulative of All Courses

COGNITIVE STYLE MAPPING

Questions 1 and 2

* May be a good idea to make extensive use of tape recordings in reviewing assignments. May record reading assignments on tape.

* When taking notes you should be careful to take only those notes that are relevant. Become proficient at concise notes.

* You may learn better in lecture classes.

* Sometimes after reading something you do not understand, read it aloud.

* When instructor is giving written instructions try to have them read aloud.

* If you have a choice, take oral exams.

* Schedule courses where a lot of information is given verbally.

* Have someone read questions about assignments to you.

* When studying, you should create a silent environment. That is, since you learn predominantly auditory symbolization it is best to create the kind of study environment where there is absolutely no noise.

Questions 3 and 4

* Take extensive notes. Write everything down. You may want to rewrite notes after class to make them more accurate.

* Be certain to get every step written in a sequence, especially in mathematics.

* Learn how to mark key points in a book.

* Encourage instructors to give handouts over lectures.

* Make frequent use of graphs and charts.

* Make full use of writing skills.

* Increase reading skills if possible by taking reading courses.

* Schedule classes which require predominantly reading.

* Develop a daily schedule.

* Record the amount of time that you study.

* You learn best when a lot of visuals are used.

* Should remove all visual distractions.

TEXTBOOKS AT AUSTIN COMMUNITY COLLEGE

Mth 1311 Applied Mathematics I: The Metric System

Module SI: The Metric System, by Gersting (Cummings)

Mth 1312 Applied Mathematics II: Applied Elementary Geometry

Introduction to Geometry, by Allyn Washington (Cummings

Mth 1321 Applied Mathematics III: Applied Elementary Trigonometry

Introduction to Trigonometry, by Allyn Washington (Cummings)

Mth 1322 Applied Mathematics IV: Applied Elementary Algebra

Mathematics at Work: Algebra, by Singer (Gregg/McGraw-Hill)

MTh 1403 Prealgebra Mathematics

Practical Arithmetic, by Johnson (Prentice-Hall)

Mth 1413 Elementary Algebra

Basic Algebra: A Semi-Programmed Approach, by Gilligan and Neno (Goodyear)

Mth 1423 Intermediate Algebra

Intermediate Algebra (2nd Ed), by Lial and Miller (Scott, Foresman)

Mth 1513 Mathematics: Its Spirit and Use

Mathematics and the modern World, by Triola (Benjamin, Cumming)

Mth 1523 Modern Mathematics I + II

Basic Concepts of Mathematics for Elementary Teachers, by Dubisch (Addison Wesley)

Mth 1563 Elementary Statistics

Descriptive and Inferential Statistics, by Downie and Starry (Harper & Row)

Mth 1643 Mathematics for Business and Economics I + II

College Mathematics for Management, Life, and Social Sciences, (Dellen)

Mth 1743 College Algebra

Fundamentals fo College Algebra (4th Ed.), by Swokowski (Prendel, Weber & Schmidt)

Mth 1753 Trigonometry

Trigonometry, by Lial and Miller (Scott Foresman)

Mth 1764 Precalculus

Functions and Graphs, by Swokowski (Prendle, Weber & Schmidt)

Mth 1854 Calculus I, II, III

Calculus with Analytic Geometry, by Swokowski (Prendle, Weber, & Schmit)

Mth 2164 Differential Equations

Elementary Differential Equations (5th Ed.), by Rainville (McMillan)

BIBLIOGRAPHY

Cross, K. Patricia, Accent on Learning, Jossey-Bass Publishers, 1976.

Keeton, Morris T. & Assoc., Experiential Learning, Jossey-Bass Publishers, 1976.

Messick, Samuel & Assoc., Individuality in Learning, Jossey-Bass Publishers, 1976.

Vermilye, D.W., Editor, Individualizing the System, Jossey-Bass Publishers, 1976.

Guides for the Improvement of Instruction in Higher Education, published by the Michigan State University and available from:

Instructional Media Center
Michigan State University
East Lansing, Michigan 48824

OR

Educational Development Services
College of the Mainland
Texas City, Texas 77590

Titles include:

Guide 1: Writing Useful Instructional Objectives
Guide 2: Task Descriptions and Task An. ses
Guide 3: Evaluating Instruction
Guide 4: Effective Use of Media
Guide 5: The Lecture Method
Guide 6: The Discussion Method
Guide 7: Individualized Instruction
Guide 8: Field Experience
Guide 9: The Laboratory
Guide 10: Simulation Techniques
Guide 11: Choosing Instructional Techniques
Guide 12: The Systematic Design of Instruction
Guide 13: Glossary of Terms

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